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TRANSMITTAL LETTER
(General - Patent Pending)

Docket No.
BUR920000215US1

In Re Application Of: **Agarwala et al.**

Application No.	Filing Date	Examiner	Customer No.	Group Art Unit	Confirmation No.
09/871,883	6/1/2001	Warren, Matthew E.	30449	2815	

Title: **DUAL-DAMASCENE METALLIZATION INTERCONNECTION (AS AMENDED)**

COMMISSIONER FOR PATENTS:

Transmitted herewith is:

Revised Appeal Brief (46 pages)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Agarwala et al. Docket No.: BUR920000215US1

Serial No.: 09/871,883 Group Art Unit: 2815

Filed: June 1, 2001 Examiner: Warren, Matthew E.

Title: DUAL-DAMASCENE METALLIZATION INTERCONNECTION (As Amended)

Commissioner for Patents
P.O. Box 1450
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BRIEF OF APPELLANTS

This Appeal Brief, pursuant to the Notification of Non-Compliant Appeal Brief mailed March 21, 2005, is a revised Appeal Brief in relation to the Prior Appeal Brief filed June 13, 2003, which was pursuant to the Notice of Appeal filed April 10, 2003 which was in appeal from the rejection of the Examiner dated January 13, 2003.

REAL PARTY IN INTEREST

International Business Machines, Inc. is the real party in interest.

RELATED APPEALS AND INTERFERENCES

None.

STATUS OF CLAIMS

Claims 5, 14, 21, and 26 are canceled. Claims 1-4, 6-13, 15-20, 22-25, and 27-35 are

rejected. This Brief is in support of an appeal from the rejection of claims 1-4, 6-13, 15-20, 22-25, and 27-35.

STATUS OF AMENDMENTS

There are no After-Final Amendments which have not been entered.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention discloses an interconnect structure, comprising a lower level wire (200) and an upper level wire (205). The lower level wire (200) is in a dielectric layer (245) and has a side (275) and a bottom (280). The lower level wire (200) comprises a lower core conductor (220) and a lower conductive liner (215). The lower conductive liner (215) is on the side (275) and the bottom (280) of the lower level wire (200). The lower conductive liner (215) has an upper edge (285) having an inner surface, an outer surface, and a top surface. The top surface of the upper edge (285) is substantially coplanar with a top surface of the dielectric layer (245). The upper level wire (205) has a side and a bottom (260). The upper level wire (205) comprises an upper core conductor (230) and an upper conductive liner (225). The upper conductive liner (225) is on the side and the bottom (260) of the upper level wire (205), and at least a portion of the bottom (260) of said upper level wire (205) extends below a top surface of said lower wire level (200). The upper conductive liner (225) is in contact with said lower core conductor (220) and also in contact with both the inner surface and the outer surface of the upper edge (285) of the lower conductive liner (215) in a liner-to-liner contact region. See FIGS. 3 and 4A and description thereof in the specification on page 16, line 8 - page 18, line 19.

The lower level wire (200) may be formed by a damascene process in a lower level dielectric (245), and the upper level wire (205) may be formed by a damascene process in an upper level dielectric (255). See specification, page 17, lines 12-15.

The upper core conductor (230) and lower core conductor (220) may each be selected from the group consisting of copper, aluminum, aluminum-copper and aluminum-copper-silicon. See specification, page 17, line 21 - page 18, line 2.

The upper conductive liner (225) and lower conductive liner (215) may each be selected from the group consisting of tantalum, tantalum nitride, titanium, titanium nitride, tungsten and combinations thereof. See specification, page 17, lines 18-21.

The liner-to liner contact region may comprise a first portion co-extensive with the lower conductive liner (215) on a portion of a first side of said lower level wire (200) under the upper level wire (205). The liner-to liner contact region may further comprise a second portion co-extensive with the lower conductive liner on a portion of a second side of the lower level wire (200) under said upper level wire (205). The liner-to-liner contact region may further comprise a third portion co-extensive with the lower conductive liner (215) on an end of the lower level wire (200) under the upper level wire (205). See specification, FIGS. 3 and 4A and page 17, lines 4-6; FIG. 7 and page 24, lines 10-13.

The dielectric layers (245) and (255) may each be selected from the group consisting of silicon oxide, silicon nitride, diamond, fluorine doped silicon oxide, spin on glass, porous silicon oxide, polyimide, polyimide siloxane, polysilsequioxane polymer, benzocyclobutene, paralyene N, paralyene F, polyolefin, poly-naphthalene, amorphous Teflon, SILK™, black diamond, polymer foam, aerogel, air, dielectric gases, a partial vacuum and combinations thereof. See

specification, page 19, lines 1-10.

The upper level wire (205) may have a via (210) integrally formed in the bottom of the upper level wire (205). The via (210) has a side (265) and a bottom (270). The via (210) comprises the upper core conductor (230), and a conductive liner (225) on the side (265) and bottom (270) of the via (210). At least a portion of the bottom (265) of the via (210) extends below a top surface of said lower level wire (200). The upper conductive liner (225) on the bottom (270) of the via (210) is in contact with the lower core conductor (220) and is also in contact with both the inner surface and the outer surface of said upper edge (285) of said lower conductive liner (215) in a liner-to-liner contact region.. See FIGS. 3 and 4A; see specification, page 16, lines 15-16 and page 18, lines 9-12.

The liner-to liner contact region may comprise a first portion co-extensive with the lower conductive liner (215) on a portion of a first side of said lower level wire (200) under the via (210). The liner-to liner contact region may further comprise a second portion co-extensive with the lower conductive liner (215) on a portion of a second side of the lower level wire (200) under the via (210). The liner-to-liner contact region may further comprise a third portion co-extensive with the lower conductive liner (215) on an end of the lower level wire (200) under the via (210). See specification, FIGS. 3 and 4A and page 17, lines 4-6; FIG. 7 and page 24, lines 10-13.

The upper level wire (205) may have an array of vias (210A, ..., 210I) integrally formed in the bottom of said upper level wire (205). Each via (210) of the array of vias (210A, ..., 210I) has a side and a bottom. Each via (210) comprises the upper core conductor (230), and a conductive liner (225) on the side (265) and the bottom (270) of each via (210). At least a portion of the bottom (270) of each via (210) extends below the top surface of the lower wire

level (200). The upper conductive liner (225) on the bottom (270) of each via (210) of a first portion of the array of vias is in contact with the lower core conductor (220) and each via (210) of a second portion of the array of vias (210A, ..., 210I) is in contact with the lower core conductor (220) and is also in contact with both the inner surface and the outer surface of the upper edge of the lower conductive liner (215) in liner-to-liner contact regions. The liner-to liner contact region may comprise first portions co-extensive with the lower conductive liner (215) on portions of first sides of the lower level wire (200) under vias (210) of the second portion of said array of vias (210A, ..., 210I). The liner-to liner contact region may further comprise second portions co-extensive with the lower conductive liner (215) on portions of second sides of the lower level wire (200) under vias (210) of the second portion of the array of vias (210A, ..., 210I). The liner-to-liner contact region may further comprise a third portion co-extensive with the lower conductive liner (215) on an end of the lower level wire (200) under vias of the second portion of the array of vias (210A, ..., 210I). See FIGS. 12-16 and description thereof in the specification on page 30, line 3 - page 35, line 11; FIGS. 3 and 4A.

The lower level wire (200) may have one or more integral extensions with each extension having a side and a bottom and extending laterally from the side of the lower level wire (200). The extensions may comprising the lower core conductor (220) and the lower conductive liner (215) such that the lower conductive liner (215) is on the side of the extensions. See FIG. 10 and the specification on page 27, lines 10-21; see FIG. 12 and the specification on page 30, lines 10-16; FIGS. 3 and 4A.

The present invention also discloses an interconnect structure, comprising a lower level wire (200), one or more dielectric pillars (365) , and an upper level wire (205). The lower level

wire (200) has a side and a bottom. The lower level wire (200) comprises a lower core conductor (220), and a lower conductive liner (215) on the side and the bottom of the lower level wire (200). The one or more dielectric pillars (365) are formed in the lower level wire (200), and the lower conductive liner (215) is on sides of the dielectric pillars (365). The upper level wire (205) has a side and a bottom. The upper level wire (205) comprises an upper core conductor (230) and an upper conductive liner (225), wherein the upper conductive liner (225) is on the side and the bottom of the upper level wire (205) . The upper conductive liner (225) is in contact with the lower core conductor (220) and also in contact with the lower conductive liner (215) on the sides of the dielectric pillars (365) in liner-to-liner contact regions. The upper level wire (205) may have one or more vias integrally formed in the bottom of the upper level wire (205), with each via (210) having a side and a bottom. Each via (210) may comprise the upper core conductor (230) and an conductive liner (225), wherein the conductive liner (225) is on the side and the bottom of each via (210). The liner (225) on the bottom of at least a portion of the one or more vias (210A, ..., 210I) may be in contact with the lower core conductor (220) and at least a portion of the one or more vias (210A, ..., 210I) may be in contact with the lower conductive liner (215) on the side of at least a portion of the one or more dielectric pillars (365) in liner-to-liner contact regions. See FIGS. 17-18 and description thereof in the specification on page 35, line 12 - page 36, line 20; FIGS. 3 and 4A.

The liner-to liner contact region may comprise first portions co-extensive with the lower conductive liner (215) on portions of first sides of the dielectric pillars (365) under the vias (210). The liner-to liner contact region may further comprise second portions co-extensive with the lower conductive liner (215) on portions of second sides of the dielectric pillars (365) under

the vias (210). The liner-to-liner contact region further may comprise a third portion co-extensive with the lower conductive liner (215) on portions of third sides of the dielectric pillars (365) under the vias (210). See FIGS. 20A-20B and description thereof in the specification on page 37, line 16 - page 38, line 12; FIGS. 3 and 4A.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1-4, 6-13, 15-20, 22-25, 27-29 stand rejected under 35 U.S.C. §103(a) over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651).

2. Claims 30-33 stand rejected under 35 U.S.C. §103(a) over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2).

3. Claims 34 and 35 stand rejected under 35 U.S.C. §103(a) over Farrar et al. (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2) and in further view of Havemann (US 6,156,651).

ARGUMENT

GROUND OF REJECTION 1

Claims 1-4, 6-13, 15-20, 22-25, 27-29 stand rejected under 35 U.S.C. §103(a) over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651).

The Examiner rejected claims 1-4, 6-13, 15-20, 22-25, 27-29 under 35 U.S.C. §103(a) as allegedly unpatentable over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651). The Examiner alleges:

Claims 1-4, 6, and 9

Appellant contends that the Examiner's rejection of claim 1 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claim 1 under 35 U.S.C. §103(a) is improper is that neither Farrar nor Havemann teaches or suggests the following feature of claim 1: "at least a portion of the bottom of said upper level wire extending below a top surface of said lower wire level".

The Examiner admits that Farrar does not teach or suggest the preceding feature of claim 1 by stating "Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level" (see Office Action mailed 01/13/2003, page 4, lines 1-2). The Examiner argues: "Havemann shows (fig. 3G) an interconnect structure in which a lower level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact

region. A portion of the bottom of the upper level wire extends below a top surface of the lower wire level".

In response, Appellants contend that the preceding argument by the Examiner in the Examiner's is invalid, since Havemann does not teach or suggest that the upper liner 48 is conductive as required by claim 1. In particular, Havemann teaches that the liner 48 is made of silicon nitride which is insulative ant thus non-conductive.

A second reason why the Examiner's rejection of claim 1 under 35 U.S.C. §103(a) is improper is that the Examiner has not provided any reason for combining Farrar with Havemann for the following feature of claim 1 not taught by Farrar: "at least a portion of the bottom of said upper level wire extending below a top surface of said lower wire level". Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 1, and the rejection of claim 1 should accordingly be reversed.

A third reason why the Examiner's rejection of claim 1 under 35 U.S.C. §103(a) is improper is that, even if the Examiner's had stated a reason for combining Farrar with Havemann in relation to the aforementioned feature of claim 1 (which the Examiner hasn't as explained *supra*), the Examiner developed his argument for combining Havemann with Farrar on the assumption that Havemann teaches forming a contact "without mechanical **defects**" (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact "without mechanical defects" as alleged by the Examiner. The Havemann abstract referred to by the Examiner specifically recites: "Methods are shown for realizing desirable

insulating and conducting layers without deleterious mechanical **effects**" (emphasis added). The Examiner has incorrectly concluded that a "defect" is equivalent to an "effect". Appellant maintains that a "defect" is "a fault or imperfection". *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an "effect" is "something that is produced by an agency or cause; result; consequence". *Id.* at 420. Therefore, the Examiner's argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 1, and the rejection of claim 1 should accordingly be reversed.

In addition, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in order to realize insulating and conducting layers without deleterious mechanical effects.

Furthermore, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not

obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved. Therefore, it would not be obvious to combine Farrar with Havemann, and the rejection of claim 1 should be reversed.

Based on the any of the preceding arguments, Appellant contends that claim 1 is not unpatentable over Farrar in view of Havemann and the rejection of claim 1 under 35 U.S.C. §103(a) should accordingly be reversed.

Since claims 2-4 and 9 depend from claim 1, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 2-4, 6, and 9 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 2-4, 6, and 9 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 7-8

Since claims 7-8 depend from claim 1, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 7-8 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 7-8 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, Appellants contend that Farrar in view of Havemann does not teach or suggest the following feature of claims 7-8: "wherein said liner-to liner contact region further comprises a second portion co-extensive with said lower conductive liner on a portion of a

second side of said lower level wire under said upper level wire" (claim 7); and "wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under said upper level wire" (claim 8).

The Examiner alleges that Havemann teaches: "An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region.... The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire."

Thus the Examiner argues that the layer 48 is the upper conductive layer that forms part of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the Examiner's argument for rejecting claims 7-8 is erroneous, and the rejection of claims 7-8 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 10-13, 15, and 19

Appellant contends that the Examiner's rejection of claim 10 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claim 10 under 35 U.S.C. §103(a) is

improper is that neither Farrar nor Havemann teaches or suggests the following feature of claim 10: "at least a portion of the bottom of **said via** extending below a top surface of said lower wire level" (emphasis added). The Examiner admits that Farrar does not teach or suggest the preceding feature of claim 10 by stating "Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level" (see Office Action mailed 01/13/2003, page 4, lines 1-2). As to Havemann, the Examiner has made no argument concerning **said via** in relationship to the preceding feature of claim 10. Indeed, the Examiner has not identified any via in Havemann and the Examiner has not even alleged that Havemann discloses a via. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 10, and the rejection of claim 10 should accordingly be reversed.

A second reason why the Examiner's rejection of claim 10 under 35 U.S.C. §103(a) is improper is that the Examiner has not provided any reason for combining Farrar with Havemann for the following feature of claim 10 not taught by Farrar: "at least a portion of the bottom of said via extending below a top surface of said lower wire level". Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 10, and the rejection of claim 10 should accordingly be reversed.

A third reason why the Examiner's rejection of claim 10 under 35 U.S.C. §103(a) is improper is that, even if the Examiner's has stated a reason for combining Farrar with Havemann in relation to the aforementioned feature of claim 10 (which the Examiner hasn't as explained *supra*), the Examiner developed his argument for combining Havemann with Farrar (though not for claim 10) on the assumption that Havemann teaches forming a contact "without mechanical

defects" (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact "without mechanical defects" as alleged by the Examiner. The Havemann abstract referred to by the Examiner specifically recites: "Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical **effects**" (emphasis added). The Examiner has incorrectly concluded that a "defect" is equivalent to an "effect". Appellant maintains that a "defect" is "a fault or imperfection". *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an "effect" is "something that is produced by an agency or cause; result; consequence". *Id.* at 420. Therefore, the Examiner's argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 10, and the rejection of claim 10 should accordingly be reversed.

In addition, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in order to realize insulating and conducting layers without deleterious mechanical effects.

Furthermore, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would

improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved. Therefore, it would not be obvious to combine Farrar with Havemann, and the rejection of claim 10 should be reversed.

Based on the any of the preceding arguments, Appellant contends that claim 10 is not unpatentable over Farrar in view of Havemann and the rejection of claim 10 under 35 U.S.C. §103(a) should accordingly be reversed.

Since claims 11-13, 15 and 19 depend from claim 10, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 11-13, 15, and 19 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 11-13, 15, and 19 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 16-18

Since claims 16-18 depend from claim 10, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 16-18 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 16-18 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, Appellants contend that Farrar in view of Havemann does not teach or suggest the following feature of claims16-18: "wherein said liner-to liner contact region further comprises a second portion co-extensive with said lower conductive liner on a portion of a second side of said lower level wire under said via" (claim 16); "wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under said via" (claim 17); and "wherein said liner-to liner contact region comprises a first portion co-extensive with said lower conductive liner on a portion of a first side of said lower level wire under said via and a second portion co-extensive with said lower conductive liner on a portion of an end of said lower level wire under said via" (claim 18).

Firstly, the Examiner has not made any argument with respect to the preceding feature of claims 16-18, since the preceding feature of claims 16-18 relates to a via, and the Examiner has not even alleged that Havemann discloses a via as discussed *supra*.

Secondly, the Examiner alleges that Havemann teaches: "An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region.... The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire."

Thus the Examiner argues that the layer 48 is the upper conductive layer that forms part

of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the Examiner's argument for rejecting claims 16-18 is erroneous, and the rejection of claims 16-18 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 20 and 22

Appellant contends that the Examiner's rejection of claim 20 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claim 20 under 35 U.S.C. §103(a) is improper is that neither Farrar nor Havemann teaches or suggests the following feature of claim 20: "at least a portion of the bottom **each via** extending below a top surface of said lower wire level" (emphasis added). The Examiner admits that Farrar does not teach or suggest the preceding feature of claim 20 by stating "Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level" (see Office Action mailed 01/13/2003, page 4, lines 1-2). As to Havemann, the Examiner has made no argument concerning **each via** in relationship to the preceding feature of claim 20. Indeed, the Examiner has not identified any via in Havemann and the Examiner has not even alleged that Havemann discloses a via. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 20, and the rejection of claim 20 should accordingly be reversed.

A second reason why the Examiner's rejection of claim 20 under 35 U.S.C. §103(a) is improper is that the Examiner has not provided any reason for combining Farrar with Havemann for the following feature of claim 20 not taught by Farrar: "at least a portion of the bottom each via extending below a top surface of said lower wire level". Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 20, and the rejection of claim 20 should accordingly be reversed.

A third reason why the Examiner's rejection of claim 20 under 35 U.S.C. §103(a) is improper is that, even if the Examiner's has stated a reason for combining Farrar with Havemann in relation to the aforementioned feature of claim 20 (which the Examiner hasn't as explained *supra*), the Examiner developed his argument for combining Havemann with Farrar (though not for claim 20) on the assumption that Havemann teaches forming a contact "without mechanical **defects**" (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact "without mechanical defects" as alleged by the Examiner. The Havemann abstract referred to by the Examiner specifically recites: "Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical **effects**" (emphasis added). The Examiner has incorrectly concluded that a "defect" is equivalent to an "effect". Appellant maintains that a "defect" is "a fault or imperfection". *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an "effect" is "something that is produced by an agency or cause; result; consequence". *Id.* at 420. Therefore, the Examiner's argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to

claim 20, and the rejection of claim 20 should accordingly be reversed.

In addition, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in order to realize insulating and conducting layers without deleterious mechanical effects.

Furthermore, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved. Therefore, it would not be obvious to combine Farrar with Havemann, and the rejection of claim 20 should be reversed.

Based on the any of the preceding arguments, Appellant contends that claim 20 is not unpatentable over Farrar in view of Havemann and the rejection of claim 20 under 35 U.S.C. §103(a) should accordingly be reversed.

Since claim 22 depends from claim 20, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claim 22 is likewise not unpatentable over Farrar in view of Havemann and the rejection of claim 22 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 23-24

Since claims 23-24 depend from claim 20, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 23-24 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 23-24 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, Appellants contend that 23-24 Farrar view of Havemann does not teach or suggest the following feature of claims 23-24: "wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second sides of said lower level wire under vias of said second portion of said array of vias" (claim 23); and "wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under vias of said second portion of said array of vias" (claim 24).

Firstly, the Examiner has not made any argument with respect to the preceding feature of claims 23-24, since the preceding feature of claims 23-24 relates to vias, and the Examiner has not even alleged that Havemann discloses vias as discussed *supra*.

Secondly, the Examiner alleges that Havemann teaches: "An upper level wire has an

upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region.... The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire."

Thus the Examiner argues that the layer 48 is the upper conductive layer that forms part of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the Examiner's argument for rejecting claims 23-24 is erroneous, and the rejection of claims 23-24 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 25 and 27

Appellant contends that the Examiner's rejection of claim 25 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claim 25 under 35 U.S.C. §103(a) is improper is that neither Farrar nor Havemann teaches or suggests the following feature of claim 25: "at least a portion of the bottom **each via** extending below a top surface of said lower wire level" (emphasis added). The Examiner admits that Farrar does not teach or suggest the

preceding feature of claim 25 by stating "Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level" (see Office Action mailed 01/13/2003, page 4, lines 1-2). As to Havemann, the Examiner has made no argument concerning **each via** in relationship to the preceding feature of claim 25. Indeed, the Examiner has not identified any via in Havemann and the Examiner has not even alleged that Havemann discloses a via. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 25, and the rejection of claim 25 should accordingly be reversed.

A second reason why the Examiner's rejection of claim 25 under 35 U.S.C. §103(a) is improper is that the Examiner has not provided any reason for combining Farrar with Havemann for the following feature of claim 25 not taught by Farrar: "at least a portion of the bottom each via extending below a top surface of said lower wire level". Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 25, and the rejection of claim 25 should accordingly be reversed.

A third reason why the Examiner's rejection of claim 25 under 35 U.S.C. §103(a) is improper is that, even if the Examiner's has stated a reason for combining Farrar with Havemann in relation to the aforementioned feature of claim 25 (which the Examiner hasn't as explained *supra*), the Examiner developed his argument for combining Havemann with Farrar (though not for claim 25) on the assumption that Havemann teaches forming a contact "without mechanical **defects**" (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact "without mechanical defects" as alleged by the Examiner. The Havemann abstract referred to by the Examiner specifically recites: "Methods are shown for

realizing desirable insulating and conducting layers without deleterious mechanical **effects**" (emphasis added). The Examiner has incorrectly concluded that a "defect" is equivalent to an "effect". Appellant maintains that a "defect" is "a fault or imperfection". *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an "effect" is "something that is produced by an agency or cause; result; consequence". *Id.* at 420. Therefore, the Examiner's argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 25, and the rejection of claim 25 should accordingly be reversed.

In addition, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in order to realize insulating and conducting layers without deleterious mechanical effects.

Furthermore, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not

obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved. Therefore, it would not be obvious to combine Farrar with Havemann, and the rejection of claim 25 should be reversed.

Based on the any of the preceding arguments, Appellant contends that claim 25 is not unpatentable over Farrar in view of Havemann and the rejection of claim 25 under 35 U.S.C. §103(a) should accordingly be reversed.

Since claim 27 depends from claim 25, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claim 27 is likewise not unpatentable over Farrar in view of Havemann and the rejection of claim 27 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 28-29

Since claims 28-29 depend from claim 25, which Appellants has argued *supra* is not unpatentable over Farrar in view of Havemann, Appellants contend that claims 23-24 are likewise not unpatentable over Farrar in view of Havemann and the rejection of claims 23-24 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, Appellants contend that 28-29 Farrar view of Havemann does not teach or suggest the following feature of claims 28-29: "wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second

sides of said lower level wire under vias of said second portion of said array of vias" (claim 28); and "wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under vias of said second portion of said array of vias" (claim 29).

Firstly, the Examiner has not made any argument with respect to the preceding feature of claims 28-29, since the preceding feature of claims 28-29 relates to vias, and the Examiner has not even alleged that Havemann discloses vias as discussed *supra*.

Secondly, the Examiner alleges that Havemann teaches: "An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region.... The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire."

Thus the Examiner argues that the layer 48 is the upper conductive layer that forms part of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the Examiner's argument for rejecting claims 28-29 is erroneous, and the rejection of claims 28-29 under 35 U.S.C. §103(a) should accordingly be reversed.

GROUND OF REJECTION 2

Claims 30-33 stand rejected under 35 U.S.C. §103(a) over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2).

Claims 30-31

Appellant contends that the Examiner's rejection of claims 30-31 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claims 30-31 under 35 U.S.C. §103(a) is improper is that neither Farrar nor Otsuka teaches or suggests the following feature of claim 30: "said lower conductive liner on sides of said dielectric pillars". The Examiner admits that "Farrar shows all of the elements of the claims except the dielectric pillars formed in the lower level wire." The Examiner alleges: "Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2, lines 50-52)." Appellants contend that the Examiner does not even allege that Otsuka teaches or suggests "said lower conductive liner on sides of said dielectric pillars". Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 30, and the rejection of claim 30 should accordingly be reversed.

A second reason why the Examiner's rejection of claims 30-31 under 35 U.S.C. §103(a) is improper is that the Examiner's reason for combining Farrar and Otsuka is not persuasive. The Examiner argues: "Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2,

lines 5052). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lower interconnect wiring level of Farrar by adding dielectric pillars as taught by Otsuka et al. to form a highly reliable damascene wiring structure." Appellant contends that the improved reliability against void formation taught by Otsuka is not required in Farrar because Farrar already utilizes a different method of improved reliability against void formation. Otsuka teaches in col 3, lines 37 to 43: "With these structures described above, a diameter of crystal grains in the upper wiring above the via hole becomes small so stress migration can be suppressed and wiring disconnections can be reduced. Wiring defects to be caused by stress migration can be suppressed even if a wide wire is formed by using the dual damascene process." Appellant points out that layers 323, 383, 384 of Farrar already mitigate against stress migration by surrounding the core conductors (copper) with metals not subject to stress migration (tantalum, and tantalum nitride) thus maintaining electrical contact even if voids form in the core conductor. Therefore, there is no need to apply the solution of Otsuka to a problem already solved by Farrar. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 30-31, and the rejection of claims 30-31 should accordingly be reversed.

A third reason why the Examiner's rejection of claims 30-31 under 35 U.S.C. §103(a) is improper is that formation of dielectric pillars in Farrar's structure would add an unnecessary expense that Farrar specifically teaches to avoid in col. 2. lines 37 to 42 by stating "If however the lines are made wider, fewer wiring channels can be provided in each metal level. To obtain the same number of wiring channels, additional levels of metal must be provided. This increases the chip cost. So if this approach is to be followed, it is imperative that a low cost process be

adopted.," and in col. 4, lines 61 to 62 further stating "What is disclosed herein is a low cost process to achieve reduced capacitance and resistance loss in wiring levels." Appellant contends that addition of the dielectric pillars of Otsuka to Farrar are not necessary and add an un-necessary expense to the fabrication of Farrar's structure. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 30-31, and the rejection of claims 30-31 should accordingly be reversed.

Based on the any of the preceding arguments, Appellant contends that claims 30-31 is not unpatentable over Farrar in view of Otsuka and the rejection of claims 30-31 under 35 U.S.C. §103(a) should accordingly be reversed.

Claim 32

Since claim 32 depends from claim 31, which Appellants has argued *supra* is not unpatentable over Farrar in view of Otsuka, Appellants contend that claim 32 is likewise not unpatentable over Farrar in view of Otsuka and the rejection of claim 32 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, the Examiner has not made even a single argument to show that Farrar in view of Otsuka discloses the following feature of claim 32: " wherein said lower conductive liner on the side of said one or more dielectric pillars includes an upper edge having an inner surface, an outer surface, and a top surface and said upper conductive liner on the bottom of vias of said second portion of said array of vias contact one or more of said inner, outer and top surfaces to form said liner-to-liner contact region." Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 32, and the rejection of

claim 32 should accordingly be reversed.

Claim 33

Since claim 33 depends from claim 31, which Appellants has argued *supra* is not unpatentable over Farrar in view of Otsuka, Appellants contend that claim 33 is likewise not unpatentable over Farrar in view of Otsuka and the rejection of claim 33 under 35 U.S.C. §103(a) should accordingly be reversed.

In addition, the Examiner has not made even a single argument to show that Farrar in view of Otsuka discloses the following feature of claim 33: "wherein said liner-to liner contact region comprises first portions co-extensive with said lower conductive liner on portions of first sides of said dielectric pillars under said vias" Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claim 33, and the rejection of claim 33 should accordingly be reversed.

GROUND OF REJECTION 3

Claims 34 and 35 stand rejected under 35 U.S.C. §103(a) over Farrar et al. (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2) and in further view of Havemann (US 6,156,651).

Claims 34-35

Appellant contends that the Examiner's rejection of claims 34-35 under 35 U.S.C. §103(a) is improper for at least the following reasons.

A first reason why the Examiner's rejection of claims 34-35 under 35 U.S.C. §103(a) is improper is that claims 34-35 depend from claim 31, which Appellants has argued *supra* is not unpatentable over Farrar in view of Otsuka. Consequently, Appellants contend that claim 33 is likewise not unpatentable over Farrar in view of Otsuka and in further view of Havemann, and the rejection of claim 33 under 35 U.S.C. §103(a) should accordingly be reversed.

A second reason why the Examiner's rejection of claims 34-35 under 35 U.S.C. §103(a) is improper is that Farrar view of Havemann and in further view of Havemann does not teach or suggest the following feature of claims 28-29: "wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second sides of said lower level wire under vias of said second portion of said array of vias" (claim 28); and "wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under vias of said second portion of said array of vias" (claim 29).

Firstly with respect to the second reason why the Examiner's rejection of claims 34-35

under 35 U.S.C. §103(a) is improper, the Examiner has not made any argument with respect to the preceding feature of claims 34-35, since the preceding feature of claims 34-35 relates to vias, and the Examiner has not even alleged that Havemann discloses vias as discussed *supra*.

Secondly with respect to the second reason why the Examiner's rejection of claims 34-35 under 35 U.S.C. §103(a) is improper, the Examiner admits that "Havemann shows (fig. 3G) an interconnect structure in which a lower level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has a upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) coextensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire-and a third portion (overlap portion of liner 48 in the hole) coextensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire. With this configuration, the interconnect can be formed without mechanical defects (abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the liner-to-liner contact region of Farrar and Otsuka by adding the second and third coextensive portions as taught by Havemann to form a contact without mechanical defects."

Thus the Examiner argues that the layer 48 is the upper conductive layer that forms part of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the

Examiner's argument for rejecting claims 34-35 is erroneous, and the rejection of claims 28-29 under 35 U.S.C. §103(a) should accordingly be reversed.

A third reason why the Examiner's rejection of claims 34-35 under 35 U.S.C. §103(a) is improper is that the Examiner developed his argument for combining Havemann with Farrar and Otsuka on the assumption that Havemann teaches forming a contact "without mechanical **defects**" (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact "without mechanical defects" as alleged by the Examiner. The Havemann abstract referred to by the Examiner specifically recites: "Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical **effects**" (emphasis added). The Examiner has incorrectly concluded that a "defect" is equivalent to an "effect". Appellant maintains that a "defect" is "a fault or imperfection". *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an "effect" is "something that is produced by an agency or cause; result; consequence". *Id.* at 420. Therefore, the Examiner's argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 34-35, and the rejection of claims 34-35 should accordingly be reversed.

In addition, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in

order to realize insulating and conducting layers without deleterious mechanical effects.

Furthermore, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved. Therefore, it would not be obvious to combine Farrar with Havemann, and the rejection of claims 34-35 should be reversed.

Based on the any of the preceding arguments, Appellant contends that claims 34-35 is not unpatentable over Farrar in view of Havemann and the rejection of claims 34-35 under 35 U.S.C. §103(a) should accordingly be reversed.

SUMMARY

In summary, Appellants respectfully request reversal of the September 9, 2003 Office Action rejection of claims 1-4, 6-13, 15-20, 22-25 and 27-35.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Agarwala et al. Docket No.: BUR920000215US1

Serial No.: 09/871,883 Group Art Unit: 2815

Filed: June 1, 2001 Examiner: Warren, Matthew E.

Title: DUAL-DAMASCENE METALLIZATION INTERCONNECTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPENDIX A - CLAIMS ON APPEAL

1. An interconnect structure, comprising:

a lower level wire in a dielectric layer, said lower level wire having a side and a bottom, said lower level wire comprising a lower core conductor and a lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire, said lower conductive liner having an upper edge having an inner surface, an outer surface, and a top surface, the top surface of said upper edge substantially coplanar with a top surface of said dielectric layer;

an upper level wire having a side and a bottom, said upper level wire comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire, at least a portion of the bottom of said upper level wire extending below a top surface of said lower wire level; and

said upper conductive liner in contact with said lower core conductor and also in contact with both the inner surface and the outer surface of said upper edge of said conductive liner in a liner-to-liner contact region.

2. The interconnect structure of claim 1, wherein said lower level wire is formed by a damascene process in a lower level dielectric and said upper level wire is formed by a damascene process in an upper level dielectric.

3. The interconnect structure of claim 1, wherein said upper and lower core conductors are selected from the group consisting of copper, aluminum, aluminum-copper and aluminum-copper-silicon.

4. The interconnect structure of claim 1, wherein said upper and lower conductive liners are selected from the group consisting of tantalum, tantalum nitride, titanium, titanium nitride, tungsten and combinations thereof.

6. The interconnect structure of claim 1, wherein said liner-to liner contact region comprises a first portion co-extensive with said lower conductive liner on a portion of a first side of said lower level wire under said upper level wire.

7. The interconnect structure of claim 6, wherein said liner-to liner contact region further comprises a second portion co-extensive with said lower conductive liner on a portion of a second side of said lower level wire under said upper level wire.

8. The interconnect structure of claim 7, wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower

level wire under said upper level wire.

9. The interconnect structure of claim 2, wherein said first and second dielectrics are selected from the group consisting of silicon oxide, silicon nitride, diamond, fluorine doped silicon oxide, spin on glass, porous silicon oxide, polyimide, polyimide siloxane, polysilsequioxane polymer, benzocyclobutene, paralyene N, paralyene F, polyolefin, poly-naphthalene, amorphous Teflon, SILK™, black diamond, polymer foam, aerogel, air, dielectric gases, a partial vacuum and combinations thereof.

10. An interconnect structure, comprising:

a lower level wire in a dielectric layer, said lower level wire having a side and a bottom, said lower level wire comprising a lower core conductor and a lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire, said lower conductive liner having an upper edge having an inner surface, an outer surface, and a top surface, the top surface of said upper edge substantially coplanar with a top surface of said dielectric layer;

an upper level wire having a side and a bottom and a via integrally formed in the bottom of said upper level wire, said via have a side and a bottom, said upper level wire and said via each comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire and on the side and bottom of said via, at least a portion of the bottom of said via extending below a top surface of said lower wire level; and

said upper conductive liner on the bottom of said via in contact with said lower core

conductor and also in contact with both the inner surface and the outer surface of said upper edge of said lower conductive liner in a liner-to-liner contact region.

11. The interconnect structure of claim 10, wherein said lower level wire is formed by a damascene or dual damascene process in a lower level dielectric and said upper level wire is formed by a dual-damascene process in an upper level dielectric.

12. The interconnect structure of claim 10, wherein said upper and lower core conductors are selected from the group consisting of copper, aluminum, aluminum-copper and aluminum-copper-silicon.

13. The interconnect structure of claim 10, wherein said upper and lower conductive liners are selected from the group consisting of tantalum, tantalum nitride, titanium, titanium nitride, tungsten and combinations thereof.

15. The interconnect structure of claim 10, wherein said liner-to liner contact region comprises a first portion co-extensive with said lower conductive liner on a portion of a first side of said lower level wire under said via.

16. The interconnect structure of claim 15, wherein said liner-to liner contact region further comprises a second portion co-extensive with said lower conductive liner on a portion of a second side of said lower level wire under said via.

17. The interconnect structure of claim 16, wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under said via.

18. The interconnect structure of claim 10, wherein said liner-to liner contact region comprises a first portion co-extensive with said lower conductive liner on a portion of a first side of said lower level wire under said via and a second portion co-extensive with said lower conductive liner on a portion of an end of said lower level wire under said via.

19. The interconnect structure of claim 11, wherein said first and second dielectrics are selected from the group consisting of silicon oxide, silicon nitride, diamond, fluorine doped silicon oxide, spin on glass, porous silicon oxide, polyimide, polyimide siloxane, polysilsequioxane polymer, benzocyclobutene, paralyene N, paralyene F, polyolefin, poly-naphthalene, amorphous Teflon, SILK™, black diamond, polymer foam, aerogel, air, dielectric gases, a partial vacuum and combinations thereof.

20. An interconnect structure, comprising:

a lower level wire in a dielectric layer, said lower level wire having a side and a bottom, said lower level wire comprising a lower core conductor and a lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire, said lower conductive liner having an upper edge having an inner surface, an outer surface, and a top surface, the top surface of said upper edge substantially coplanar with a top surface of said dielectric layer;

an upper level wire having a side and a bottom and an array of vias integrally formed in the bottom of said upper level wire, each via of said array of vias having a side and a bottom, said upper level wire and each via comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire and on the side and bottom of each via, at least a portion of the bottom each via extending below the top surface of said lower wire level; and

said upper conductive liner on the bottom of each via of a first portion of said array of vias in contact with said lower core conductor and each via of a second portion of said array of vias in contact with said lower core conductor and also in contact with both the inner surface and the outer surface of said upper edge of said lower conductive liner in liner-to-liner contact regions.

22. The interconnect structure of claim 20, wherein said liner-to liner contact region comprises first portions co-extensive with said lower conductive liner on portions of first sides of said lower level wire under vias of said second portion of said array of vias.

23. The interconnect structure of claim 22, wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second sides of said lower level wire under vias of said second portion of said array of vias.

24. The interconnect structure of claim 23, wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower

level wire under vias of said second portion of said array of vias.

25. An interconnect structure, comprising:

a lower level wire in a dielectric layer, said lower level wire having a side and a bottom and one or more integral extensions each extension having a side and a bottom and extending laterally from the side of said lower level wire, said lower level wire and extensions comprising a lower core conductor and an lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire and said extensions, said lower conductive liner having an upper edge having an inner surface, an outer surface, and a top surface, the top surface of said upper edge substantially coplanar with a top surface of said dielectric layer;

an upper level wire having a side and a bottom and an array of vias integrally formed in the bottom of said upper level wire, each via of said array of vias having a side and a bottom, said upper level wire and each via comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire and on the side and bottom of each via, at least a portion of the bottom each via extending below a top surface of said extensions of said lower wire level; and

said upper conductive liner on the bottom of each said via of a first portion of said array of vias in contact with said lower core conductor of said lower level wire and a second portion of said array of vias in contact with said lower core conductor of said extensions and also in contact with both the inner surface and the outer surface of said upper edge of said lower conductive liner of said extensions in liner-to-liner contact regions.

27. The interconnect structure of claim 25, wherein said liner-to liner contact region comprises first portions co-extensive with said lower conductive liner on portions of first sides of said extensions of said lower level wire under vias of said second portion of said array of vias.

28. The interconnect structure of claim 27, wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second sides of said extensions of said lower level wire under vias of said second portion of said array of vias.

29. The interconnect structure of claim 28, wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under vias of said second portion of said array of vias.

30. An interconnect structure, comprising:

a lower level wire having a side and a bottom, said lower level wire comprising a lower core conductor and a lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire;

one or more dielectric pillars formed in said lower level wire, said lower conductive liner on sides of said dielectric pillars;

an upper level wire having a side and a bottom, said upper level wire comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire; and

said upper conductive liner in contact with said lower core conductor and also in contact with said lower conductive liner on the sides of said dielectric pillars in liner-to-liner contact regions.

31. An interconnect structure, comprising:

a lower level wire having a side and a bottom, said lower level wire comprising a lower core conductor and an lower conductive liner, said lower conductive liner on the side and the bottom of said lower level wire;

one or more dielectric pillars formed in said lower level wire, said lower conductive liner on sides of said dielectric pillars;

an upper level wire having a side and a bottom and one or more vias integrally formed in the bottom of said upper level wire, each via having a side and a bottom, said upper level wire and each via comprising an upper core conductor and an upper conductive liner, said upper conductive liner on the side and the bottom of said upper level wire and on the side and bottom of each via; and

said upper conductive liner on the bottom of at least a portion of said one or more vias in contact with said lower core conductor and at least a portion of said one or more vias in contact with said lower conductive liner on said side of at least a portion of said one or more dielectric pillars in liner-to-liner contact regions.

32. The interconnect structure of claim 31, wherein said lower conductive liner on the side of said one or more dielectric pillars includes an upper edge having an inner surface, an outer

surface, and a top surface and said upper conductive liner on the bottom of vias of said second portion of said array of vias contact one or more of said inner, outer and top surfaces to form said liner-to-liner contact region.

33. The interconnect structure of claim 31, wherein said liner-to liner contact region comprises first portions co-extensive with said lower conductive liner on portions of first sides of said dielectric pillars under said vias.

34. The interconnect structure of claim 33, wherein said liner-to liner contact region further comprises second portions co-extensive with said lower conductive liner on portions of second sides of said dielectric pillars under said vias.

35. The interconnect structure of claim 34, wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on portions of third sides of said dielectric pillars under said vias.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Agarwala et al. Docket No.: BUR920000215US1

Serial No.: 09/871,883 Group Art Unit: 2815

Filed: June 1, 2001 Examiner: Warren, Matthew E.

Title: DUAL-DAMASCENE METALLIZATION INTERCONNECTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPENDIX B - EVIDENCE

There is no evidence entered by the Examiner and relied upon by Appellants in this appeal.

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APPENDIX C - RELATED PROCEEDINGS

There are no proceedings identified in the "Related Appeals and Interferences" section.